

combined with iron ore and limestone. Then the mixture is heated to produce blast furnace gas (used in the Iron and Steel Industry). Other industries use different coal gases given off during the gasification process to make fertilizers, solvents, medicine, pesticides, and other products.

Fuel companies convert coal into easily transportable gas or liquid fuels (called synthetic fuels). Coal-based vapor fuels are produced through the process of *gasification*. Gasification may be accomplished either at the site of the coalmine or in separate processing plants. In processing plants, the coal is heated in the presence of steam and oxygen to produce *synthesis gas*, a mixture of carbon monoxide, hydrogen, and methane which can be used as is or refined into cleaner-burning gas.

On-site gasification is accomplished by controlled, incomplete burning of coal bed while adding air and steam. To do this, workers ignite the coal bed and pump steam underground into the burning coal, and then pump the resulting gas to the surface. Once the gases are withdrawn, they may be burned to produce electricity. Or they may be used in synthetic gases to produce chemicals or refined into liquid fuels.

Liquefaction processes convert coal into a liquid fuel that has a composition similar to crude petroleum. Coal can be liquefied either by direct or indirect processes. Because coal is a hydrogen-deficient hydrocarbon, any process used to convert coal into a liquid or other alternative fuels must add hydrogen. Four general methods of coal liquefaction: (1) pyrolysis and hydrocarbonization, in which coal is heated in the presence of air or in a stream of hydrogen; (2) solvent extraction, in which coal is dissolved in a solvent and hydrogen is added to produce the desired liquid fuel; (3) direct liquefaction, in which hydrogenation takes place in the presence of a catalyst; and (4) indirect liquefaction, in which carbon monoxide and hydrogen are combined to produce a liquid fuel in the presence of a catalyst.

III COAL FORMATION

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Coal is a sedimentary rock formed from plants that flourished millions of years ago. In tropical swamps covered large areas of the world. Lush vegetation, such as mosses, horsetails, and enormous ferns, thrived in these swamps. Eventually the vegetation died and settled to the swamp bottom, and over time the organic material was buried under layers of sand and silt. As the material was buried, it was subjected to heat and pressure, which drove off oxygen and hydrogen, leaving the material with a high percentage of carbon.

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